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ULTRASOUND DIAGNOSTIC DEVICE AND METHOD OF GENERATING AN INTERMEDIARY IMAGE OF ULTRASOUND IMAGE

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 13/703,961, filed on Dec. 13, 2012, which is a U.S. National Stage patent application under 35 U.S.C. §371 of International Patent Application No. PCT/JP2011/061436, filed on May 18, 2011, which claims priority of Japanese Patent Application No. 2010-159771, filed on Jul. 14, 2010, the entire contents of each of which are hereby incorporated by reference.

TECHNICAL FIELD

The present invention relates to an ultrasound diagnostic device which acquires images by transmitting and receiving an ultrasonic wave to/from a test object. In particular, the present invention relates to an ultrasound image reconstruction method, an ultrasound image reconstruction device and an ultrasound diagnostic device for conducting a process for enhancing the spatial resolution or the temporal resolution to the acquired images by means of image processing.

BACKGROUND ART

Ultrasound diagnostic devices are used for the inspection of various parts in the body such as the abdomen and the heart. The ultrasound diagnostic devices, having advantages like harmlessness to living tissues in contrast to X-ray inspection, simple and easy operation, and possibility of video observation in real time, are widely used today. In the ultrasound diagnostic device, an ultrasound probe emits an ultrasonic wave toward the test object and receives a reflected wave from a tissue inside the test object. Based on the received reflected wave, an ultrasound image of the tissue (test object) is displayed on a monitor. In the capturing of ultrasound images, it is possible to acquire two-dimensional images or three-dimensional images in real time by scanning a converged ultrasonic wave (ultrasound beam converged in a particular direction) with respect to the azimuth direction.

Since doctors have to find and diagnose minute lesions (tumors, etc.) by observing ultrasound images by use of ultrasound diagnostic devices, the ability to acquire ultrasound images with high visibility is required of the ultrasound diagnostic devices. Further, the definition of display monitors is improving fast especially in these years, and thus enhancement of the resolution of ultrasound images is being requested accordingly.

To meet the above request, it is possible to acquire a high-resolution ultrasound image by increasing the resolution with respect to the scan azimuth direction by increasing the number of scans of the ultrasound probe per frame. It is also possible to generate a high-resolution image by conducting a deconvolution process to an acquired image for one frame (one frame image) as described in Patent Literature 1. A technique described in Non-patent Literature 1 is known as an example of the deconvolution process, in which an ideal ultrasound image with no deterioration is estimated from an acquired ultrasound image through the modeling of image blurring caused by the aberration of the ultrasound beam and image deterioration caused by the sampling.

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In a method described in Patent Literature 2, the body motion of the object under consideration (considered object) in the imaging plane is measured by using ultrasound images. Information varying with time (the shape of the considered object, tissue degradation, etc.) is visualized and displayed by adding up or subtracting time-line images while compensating for the measured body motion.

PRIOR ART LITERATURE

Patent Literature

Patent Literature 1: JP-2005-95328-A
Patent Literature 2: WO 2006/123742

Non-Patent Literature

Non-patent Literature 1: T. Taxt, R. Jirik: Superresolution of ultrasound images using the first and second harmonic signal, IEEE Trans. Ultrasonics, Ferroelectrics, and Frequency Control, Vol. 51, No. 2, pp. 163-175, 2004

SUMMARY OF THE INVENTION

Problem to be Solved by the Invention

However, even though the above method increasing the number of scans per frame is capable of acquiring high-resolution ultrasound images, the method involves a problem of decreasing the display frame rate since the time necessary for acquiring one frame image increases due to an increase in the propagation time of the ultrasonic wave. This leads to an insufficient frame rate and a hitch in the diagnosis especially in the observation of fast-moving parts (e.g., heart). Meanwhile, some problems have been known in regard to the aforementioned deconvolution process, such as occurrence of unnatural artifacts to images having much noise. Therefore, the resolution enhancement effect cannot be expected so much when the acquired ultrasound image includes much noise.

The method described in the Patent Literature 2 is capable of extracting and visualizing information varying with time from time-line images. However, the Patent Literature 2 has not described a method for acquiring high-resolution ultrasound images.

As described above, it has been difficult in the conventional technology to acquire high-resolution ultrasound images while maintaining an appropriate frame rate.

It is therefore the primary object of the present invention to resolve the above problem with the conventional technology and provide an ultrasound image reconstruction method capable of acquiring high-resolution ultrasound images while maintaining an appropriate frame rate, a device for implementing the ultrasound image reconstruction method, and an ultrasound diagnostic device employing such a device.

Means for Solving the Problem

To achieve the above object, the present invention provides an ultrasound image reconstruction method for reconstructing an ultrasound image of a sample by processing ultrasound images acquired from a signal generated by scanning the sample with an ultrasound signal by use of an ultrasound probe and receiving a reflected wave from the sample, comprising the steps of: extracting an ultrasound frame image at a certain time point and an ultrasound frame image at a time point before the certain time point from a series of ultrasound